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## DO BLOW FLY LARVÆ RESPOND TO GRAVITY?

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Referring to the fact that blow-fly larvæ crawl under objects in water just as they do outside, Loeb says (1905, p. 68):<sup>1</sup> "In these experiments I was struck by the fact that the animals, when placed under the surface of the water, do not swim upward and so avoid death, but swim downward. I cannot explain this fact. Under other conditions positive geotropism cannot be demonstrated in these animals." Relying on this statement of Loeb, I attempted to ascertain the cause of the expressed difference in response to gravity of fly-larvæ in air and in water and the method of orientation in swimming downward. The result of this investigation follows.

In making observations on the reactions of blow-fly larvæ in air, twenty-five active specimens varying in length from 5 to 17 mm. were put into a glass jar with vertical walls so situated that the light intensity in the jar was very low and approximately uniform throughout, thus eliminating its influence on the direction of movement. In the course of several minutes it was found that nearly all the larger specimens were crawling almost straight upward on the sides of the jar, apparently responding negatively to gravitation. The smaller larvæ however crawled about in all directions, horizontally and downward as well as upward. What is the cause of this difference in the direction of locomotion?

Careful observation soon showed that while most of the larger larvæ observed at any given time were directed upward, they frequently turned and started in other directions, but that as soon as they got into a position approaching the horizontal they either fell to the bottom of the jar or the posterior end swung downward somewhat every time it was raised in the process of looping, and that this resulted in orientation with the anterior end directed upward.

Thus it is clear that there is no evidence of a reaction to gravitation in these forms under the conditions of these observations, *i. e.*, in air. Do they become positive to gravity in water and swim downward as Loeb says, and if so, how do they orient?

Larvæ approximately 6 mm. long were taken from carrion

<sup>1</sup> Studies in General Physiology, Vol. I., 423 pp., Chicago.

and put into a glass jar containing water 20 cm. deep. They all soon reached the bottom, but there was not the slightest evidence of swimming downward. They did not orient and the longitudinal axis was nearly horizontal in many of them. In fact there was but little bending and twisting in the larvæ. Most of them remained perfectly quiet as they sank to the bottom and none of them deflected more than 2 cm. from the vertical. The same was true for larvæ approximately 1 cm. and 1.6 cm. long taken from the carrion and put directly into the water on the second and fifth days following. But in case of other specimens which were kept in a dish without food for several hours before they were put into the water many did not sink. This was due to the formation of small bubbles of gas near the anterior end.

Some of the larvæ which had thus been without food were killed in boiling water, others in alcohol. Of the dead specimens some sank, others floated. The dead ones were now mixed with living ones, and all put into a small glass jar containing water 80 cm. deep. After the larvæ which were heavier than water had sunk to the bottom, the jar with the upper end closed was suddenly inverted. Those which had been at the bottom sank again, while those which had been at the top rose. In both lots there were some living and some dead specimens, but it was only with great difficulty that one could distinguish them. In nearly all specimens the axis was approximately horizontal. There was no evidence whatever of a swimming movement in any of them. If there is no gas in them they sink to the bottom where they crawl about much as they do in air. If they contain bubbles of gas they float at the surface, where in one instance they were observed to remain alive more than twenty-four hours.

It must therefore be concluded that blow-fly larvæ do not react to gravity, either in water or out of it. In air they may be found to orient and crawl nearly straight upward on objects, but this is not due to a response to gravity on the part of the organisms. In water they sink to the bottom or float at the top, depending upon the amount of gas they contain, but there is no evidence whatever indicating that they can swim.